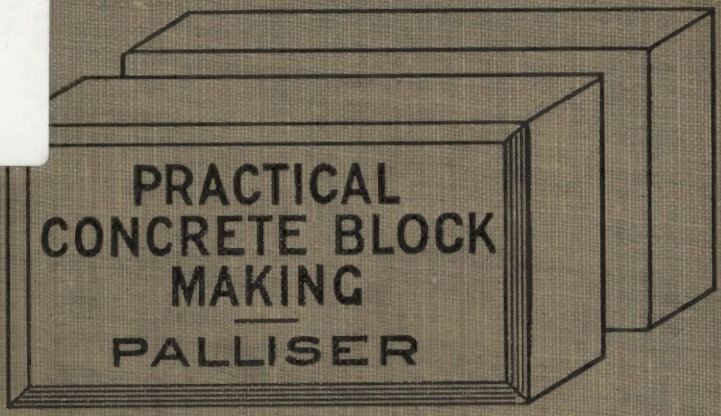
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PRACTICAL CONCRETE BLOCK MAKING

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PRACTICAL
CONCRETE-BLOCK MAKING

A SIMPLE PRACTICAL TREATISE FOR THE WORKMAN

EXPLAINING THE SELECTION OF THE MATERIALS AND THE MAKING OF SUBSTANTIAL CONCRETE BLOCKS AND CEMENT BRICK

TOGETHER WITH

DIRECTIONS FOR MAKING MOLDS AND REMARKS ON HOW TO OBTAIN THE BEST ARCHITECTURAL EFFECTS

PHILADELPHIA

BY

CHARLES PALLISER

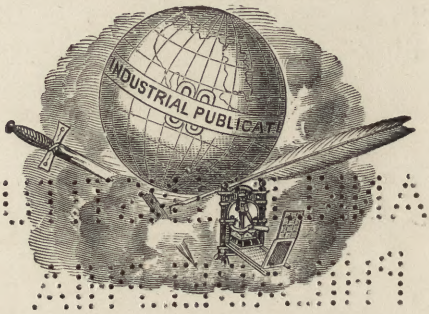
Author of "Modern Cement Sidewalk Construction," "Useful Details," "American Architecture," etc., etc.

FULLY ILLUSTRATED

NEW YORK
INDUSTRIAL PUBLICATION COMPANY
1908

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PRACTICAL CONCRETE-BLOCK MAKING



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PREFACE

THE rapid advance in the use of concrete blocks for building has tempted many to go in the business of manufacturing blocks for a living, and unfortunately many have entered the field who are ignorant of how a block should be made, and in consequence they turn out bad blocks which soon crumble.

If the blame for such poor work was put on the maker, who is at fault, we would have nothing to say, but the verdict is usually against concrete blocks, thus making them unpopular.

In this little book the writer has tried to put in simple language directions for making blocks, based upon an experience of thirty years in concrete work.

If this book will be a guide to the workman, enabling him to turn out a good, substantial, concrete block, it will fulfill the wish of

THE AUTHOR.

ELBERON, N. J., October 1, 1908.

PRACTICAL CONCRETE-BLOCK MAKING

THE fast extending employment of concrete compressed into the form of stone blocks for building work of all descriptions promises to make a new style of architecture, and the success or failure of the same will depend in large measure on what the architects accept or reject in their drawings and specifications as the best form of block, or the putting together of this material and the appearance given to its face finish. The architects' designs and details must govern these matters, and they, and they alone, must be the educators of the public in such matters of taste and art, and not the block-machine men, or the manufacturer of stone, or the contractor; but so far it would appear that the architects have in many sections been rather slow in coming forward and the other gentlemen have gone way ahead in this all-important matter. It is high time that the architects and building superintendents of the country were alive to the situation, and wherever they have been so, they have on hand far more work than they can attend to.

Concrete and other fireproof-building materials, when not fashioned aright, produce too much monotony, but it is absolutely true that in the hands of those who are practical and skilled in design and construction, these materials can be made to yield architectural effects of the greatest variety and beauty, as they are susceptible of being produced in any design of face, color, mold, or shape, and in durability are far better than any sandstone, limestone, or low-grade marble.

CEMENT AND CONCRETE

CONCRETE is the name given to a compact mass of broken stone, gravel, cinders, shells, or other suitable material joined together with mortar and allowed to harden. To prevent air spaces forming, the concrete is firmly squeezed or rammed down or "tamped," as it is called.

The mortar used is generally composed of cement and sand mixed with water.

CEMENT is a preparation of clay and limestone, or their equivalents, which has been placed in an oven or kiln and subjected to an intense heat, the clay and limestone thereby being reduced to a crumbling mass which is ground in a mill to make it a uniform powder, when it is known as cement. It possesses the property of hardening into a solid mass when moistened. The solid mass being composed of many small crystals, hence it is often

mentioned about cement crystallizing or "set," as it is called.

When a definite quantity of concrete is made at one mixing, it is called a "batch."

When concrete is tamped or rammed, it tends to close the spaces between the stones or whatever else is used for the "aggregate," and this would bring the water to the surface. When concrete is mixed with so little water that very hard ramming is required to flush the water to the surface, it is called a "dry mix," and likewise when enough water is used so that little or no ramming is needed to have it flooded, it is called a "wet mix."

BLOCKS, MOLDS, AND MACHINES

IN making concrete blocks the mixture of concrete is placed in a mold, so as to give the concrete shape and make it into a block.

The simplest arrangement is to have a common box into which the concrete is placed and tamped down, so that there will be no air holes, the concrete thus forming a thoroughly solid block.

After the concrete has been in the box for a week or ten days, it is removed from the box or mold, and the result is a block of artificial stone or, as it is called, a "concrete block."

If it simply depended on making a number of plain concrete blocks, the above method would be sufficient.

The item for making molds would amount to quite a good deal, hence one mold must do service for making a large number of blocks. The molds must be substantial and easily taken apart without jarring the concrete block

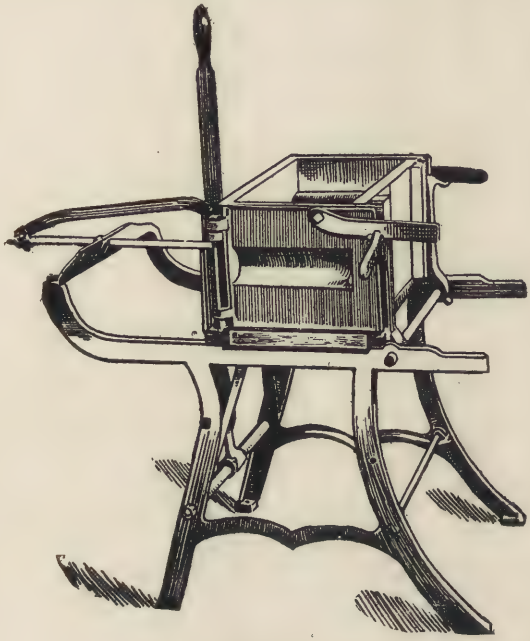


FIG. 1

(which would be likely to make it crack), so that they can be used again in a short time for the manufacture of the next block.

Wooden molds are the simplest to make and they are always used when anything out of the ordinary is called

for. For common blocks, cast-iron molds are used, as they stand hard, continuous usage. These are made so that the sides may be opened and the block easily removed. There are many different kinds of these iron molds in the market, and they are known as "concrete-block machines," some being arranged with devices to do the tamping by



FIG. 2

pressure and the sides opening so that the block may be easily removed. Fig. 1 shows one of these machines, and this shows the general principle on which all of the machines are constructed.

Concrete blocks are usually made of large size, so that the labor of building with them is lessened when compared

with brick. The most popular machines have adopted the standard length of 16 and 24 inches, a height of 9 inches, and a thickness of 8, 10, and 12 inches. Small, solid concrete blocks, the size of brick, are also made, these being used the same as brick. A machine for making "cement brick," as they are called, is shown in Fig. 2. This machine is also used for the making of "sand-lime" brick.

Full particulars about the various machines can be had from the manufacturers, whose advertisements will be found in the various building and cement papers; therefore we will not give descriptions of machines, but instead will give directions for making wooden molds, as often special designs are wanted, and the concrete-block manufacturer should know how to make the molds, so that he can turn out something more than just a mere plain block which he makes on his "machine."

It is a well-known fact that a dead air space is a poor conductor of heat, and this fact has been taken advantage of in the manufacture of blocks by making them hollow, as in that way they also use less material and, being lighter in weight than a solid block, are more easily handled. Various forms of hollow blocks are shown in Fig. 3. Practically every form is made by a certain machine, and each manufacturer declares some special advantages over all others for his particular form of block. Any one reading the remarks in this book will have no trouble in selecting a machine suitable for his own class of work. Select a machine with a good reputation and you will be sure to get one that will give satisfaction.

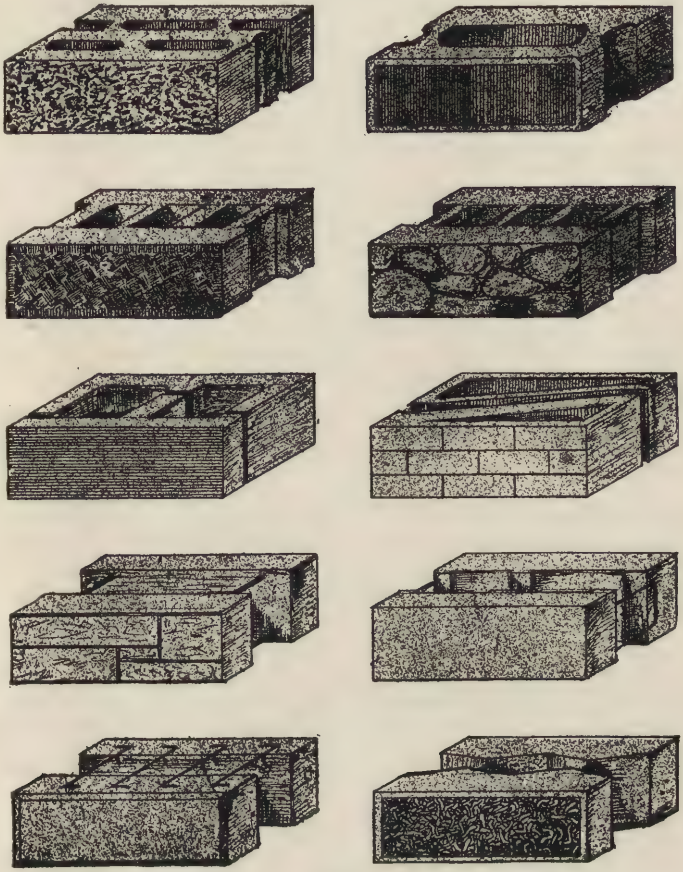


FIG. 3

DIRECTIONS FOR MANUFACTURING CONCRETE BLOCKS

THE following specifications for the manufacture of concrete blocks have in general been accepted.

SAND.—Such as will pass a screen of $\frac{1}{4}$-inch mesh and is retained by a screen of No. 40 mesh. This applies to bank, river, or beach sand, and to crusher dust.

GRAVEL.—Such as comes from a bank, river, or beach, of such size as is retained by a screen having $\frac{1}{4}$-inch mesh.

CRUSHED STONE.—Such stone as is retained by a $\frac{1}{4}$-inch screen.

BANK GRAVEL.—Such as is obtained from a pit, cellar, river, or beach, containing both sand and gravel.

AGGREGATE.—Any material, as broken stone, gravel, or such fragments used with Portland cement and sand mortar in making concrete for the purpose of reducing the cost and adding to the density and strength.

VOIDS.—Space existing between particles of sand, crushed stone, or other materials of which an aggregate is composed.

CEMENT.—Any Portland cement, American or foreign, that will pass the tests required by the American Society for Testing Materials.

QUALITY OF SAND.—Must not be finer than above described, and must contain no clay or other soluble matter. Crushed stone or gravel to be free from dirt, loam, or other foreign substance or rotten stone.

AMOUNT OF CEMENT. — A correct concrete should consist of sand and gravel or crushed stone, or a combination of same, with an amount of cement equal to the voids, or, in other words. the interstices to be filled with cement.

Some blocks are made only with sand and cement; these, properly speaking, cannot be called concrete blocks, as they are "sand-cement blocks."

If the concrete is of sand and gravel, such portion of cement shall be used with the sand that is equal to the voids in the sand, and such quantity of this mortar mixture shall be used with the crushed stone or gravel as will fill all voids in the latter.

The cement is to fill the voids in the sand, and the mortar resulting is to fill the voids in the aggregate.

DETERMINATION OF VOIDS. — To determine the voids in the sand, or the material used as an aggregate, the "water test" is employed. The sand or gravel used must be bone dry.

A receptacle holding a known amount, such as a gallon jar, is filled with the materials to be tested, and into this vessel is poured as much water as the sand or other material will absorb. Measure the water, and the amount of water absorbed indicates the voids, and also indicates the exact amount of cement which it is necessary to use in order to produce a dense, solid stone.

In making hollow blocks, if no gravel or broken stone is used, this test gives the proportions of sand and cement to be used. Average sand will absorb about 33⅓% of water, indicating that amount of voids, also that a propor-

tion of 1 part of cement to from 3 to 5 parts sand are required to make a solid block.

The proper selection of sand and aggregate is important, and the particles should vary in size so as to reduce the voids to the smallest amount possible. With care in this selection, the amount of cement needed to produce best results is greatly lessened, provided that in the defining of the proportion of cement is meant a given measure of cement as one portion, and that multiple of that measure of aggregates as properly combined, under the water test, shall determine the proportion. If found under the test that 5 parts crushed stone or gravel will take 3 portions of sand to fill the voids without increasing the bulk, and that 1 portion of cement shall fill the remaining voids, this proportion shall be a 1–3–5 mixture.

MIXING.—After selecting the materials, mix them together dry, until of a uniform color; then apply water and repeat the thorough mixing, the amount of water to be as great as possible.

More care of the face plates of any machine will enable the worker to use a wetter concrete than is usually employed. Only such size of batch shall be mixed as can be used up in 30 minutes from the time the water is added.

MANUFACTURING.—The concrete should be placed in small quantities, and tamping begun immediately and continued until the mold is full. A small-faced tamper should be used, and short, quick, sharp blows should be struck.

If faced blocks are made, use 2 parts sand and 1 part cement for facing. Tamp the concrete well into the

facing, so as to effect a bond to prevent its peeling off.

In the wet process, the amount of water used is such as will produce a plastic or flowing condition in the concrete, but not enough to wash the cement from the other material. When placing this material in the molds, fill the



FIG. 4

entire mold with one pouring. It is well to cover the face of the mold with shellac, crude oil, or a solution of gasoline and paraffin, so that the block may be easily removed from the face of the mold without injury, as when the cement is mixed with a generous supply of water, it becomes quite sticky.

Through the kindness of the Miracle Pressed Stone Company of Minneapolis, Figs. 4, 5, 6, and 7 are given,



FIG. 5

which show the operations very clearly.

Concrete blocks are most economically made by employ-

ing three men, one to do the mixing and the other two to attend to the making of the block. However, the process is simple enough, so that two or even one man can do the job.

The mixture is shoveled into the mold as shown in Fig.

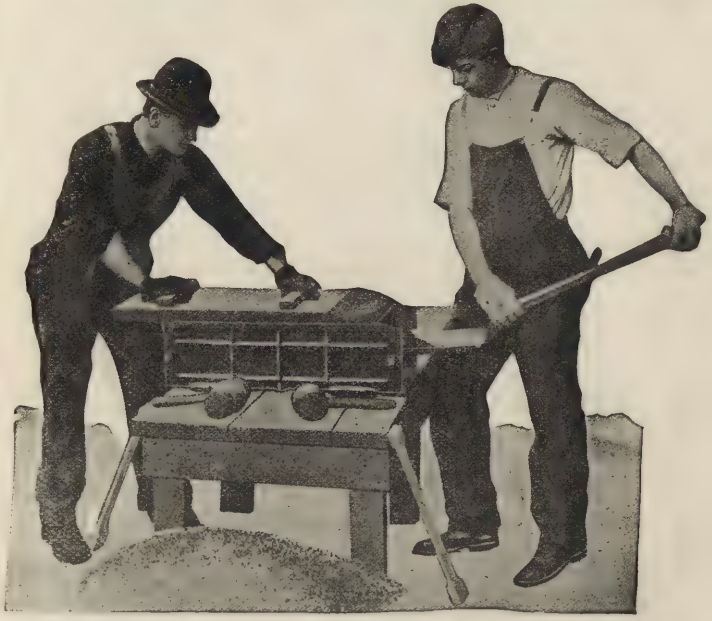


FIG. 6

4, and tamped as shown in Fig. 5. As soon as the mold is full, it is floated off, that is, all the surplus material is pushed off as shown in Fig. 6, so that the top is level.

After this operation the block has set enough so as to keep its shape if it is not jarred; hence it is carefully

removed from the mold. To do this the cores and sides are removed and the block allowed to rest on the bottom.

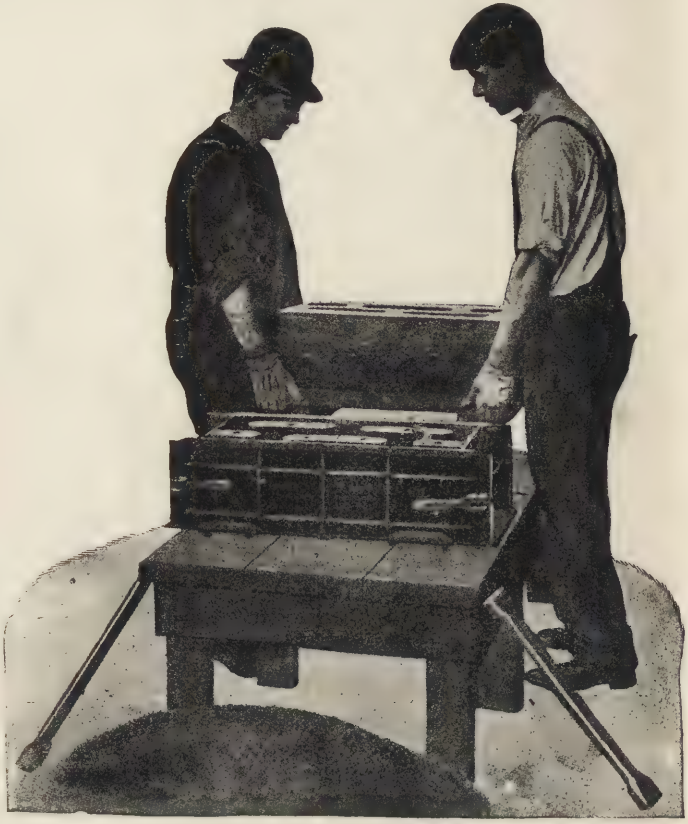


FIG. 7

The sides are then formed together again and placed on a new bottom, and the process repeated for the next block.

In the pictures the Miracle mold is shown, and this has an iron bottom, the blocks being turned upside down while in the mold on a tray or pallet made of boards of the proper width and with two cleats to keep it in shape, and which also allow sufficient room for the fingers, so that when putting it down it need not drop the least bit. This pallet can be used to level the mixture in the mold, as shown in Fig. 6, and then held in position while the mold is being turned until the block rests on the pallet, and the mold removed, and the block can then be carried away, as shown in Fig. 7.

Should any crack or defect appear in moving the "green" (freshly made) stone, throw the material back into the batch and mix it over again.

CURING.—After the block is made as above described, it is important that it be properly cured, that is, dried. This is a process that takes time, as the concrete takes time to get its full strength. The time needed is about as follows:

50% of strength in 7 days
65% " " " 30 "
95% " " " 6 months
100% " " " 1 year

Blocks should be made under cover and kept under cover for at least 10 days, and protected from the sun and dry currents of air, which would tend to dry the outside of the block first, causing unequal drying, which will make a block the inside of which will be in a poor condition. No matter how good a block is made, if it is poorly cured, it is worthless.

To prevent this rapid drying of the outside of the block (which prevents the proper crystallization of the cement), they should be kept moist by gentle sprinkling, which should be commenced as soon as the blocks will bear it without falling apart; that is, wait until the cement has set enough, so that it will prevent washing.

On a warm, dry day, they need moisture sooner than on a rainy day. To know just exactly how long to wait will be learned by experience with the first few blocks. They should be kept wet for about 10 days at least, as it gives time for the proper crystallization of the cement. When cement drys too quickly, the crystals are in the form of little balls, and, for the most strength, they should be of the needle form, which process needs moisture and slow drying.

Blocks should not be used unless they are at least one month old, and where they are subjected to any considerable weight, it is best to have a block six months old.

This subject of curing is an important one, and if you haven't the cash or credit to keep a three months' supply, you had best not start in the business, for you can be certain of one thing, and that is, if you don't turn out a good, reliable block, you will go out of business after a short time.

Proper storage room should be provided for the blocks, so that they will be protected from the sun and dry winds for the first few weeks of curing. Blocks can be safely removed from the pallets in about three or four days. It is necessary to have a good supply of the pallets on hand.

PLACING.—In placing cement stone in the wall, a soft mortar composed of cement and medium-screened sand should be used—a mortar that will work greasy under the trowel, spread evenly on the bed, and butter the ends of blocks, so as to make a solid and full set in all joints. These stones must be evenly and solidly set all round, so as to have close bearings and contact.

COLORING.—In using coloring matter, the color should always be mixed with the cement dry, before any sand or water is added. This mixing must be thorough, and the color uniform. After being mixed dry, use in the same way as clear cement.

QUANTITY OF COLORING MATTER PER SACK OF 100 POUNDS OF PORTLAND CEMENT

Color.	Dry Material Used.	Weight of Color.
Blue slate	Ultramarine blue	4 lbs.
Black slate	Excelsior carbon black	2 "
Gray	Lampblack	½ lb.
Brown	Roasted iron oxide	6 lbs.
Red	Raw iron oxide	6 to 10 lbs.
Bright red	Pompeiian red	6 lbs.
Yellow or buff	Yellow ochre	6 to 10 lbs.

BONDING.—For bonding together the inner and outer wall of the hollow block, use a material that will in nowise be a conductor of the moisture from the outside to the inside; concrete will not do under any circumstances. The only practical material is galvanized iron. Of course if concrete is used for the tie, then no claims can be made

that the inner wall will be moisture-proof, and it must be first studded off and then lathed before the plastering can be done.

In cases where the moisture (caused by the rain beating against the sides of the house) cannot penetrate to the inner wall, the plastering can be done directly on the blocks.

WATERPROOFING.—To prevent the moisture, the faces of the block and mortar are painted over with a waterproofing solution. A good one, called the Sylvester Process of Waterproofing, is as follows:

Wash the surface with a solution of three-quarters of a pound of castile soap to every gallon of water. Apply the solution hot, with a flat brush, to the wall, which must be clean and dry. Let this remain twenty-four hours and apply a solution of a half-pound of alum to four gallons of water; this wash must also be applied hot. If at the end of another twenty-four hours the wall absorbs moisture, repeat the two coats as before. Care should be taken not to have the soap solution froth while applying.

The use of milk of hydrated lime has been advocated for concrete facing and mixing, and is said to materially add to the strength and waterproofing qualities. Quicklime is also advocated. It must be thoroughly slaked with water and remain in the water for a day or two, so that all particles will dissolve. It is then called milk of lime and, after being poured through a very fine screen, can be readily used in the place of clear water for mixing the facing, and will make the color of the stone whiter and

more water-proof, but this must be very carefully used, otherwise it will have a tendency to weaken the facing. The principal essential in making stone water-proof is to make it good and to use a richer material as a facing. Hydrate of lime, la Forge non-staining cement, shell lime and marble dust, white cement, and Blanc, are all used for facing concrete blocks.

GENERAL HINTS AND SUGGESTIONS

IN the manufacture of concrete blocks, the greatest care should be exercised in the selection of the very best brand of Portland cement that can be obtained, and clean, coarse sand or screened gravel, and equal careful methods of grading, mixing, and curing must be observed. The quality and amount of sand and gravel to be mixed with the cement must receive equal careful attention, as well as the water employed for softening the mixture.

Two screens should be used, the upper one being the coarser, and the one below being fine, to allow the fine sand to go through that is too fine to use in the highest-grade work, as the particles to be used should be coarse and also uniform, while that retained by the upper screen is too coarse, or, in other words, the material that is to be used must pass through the first screen and be retained on the second screen.

Sufficient water must be used to bring the mix to a consistent paste, so that it will unite with the screened sand

and form a stiff, homogeneous mass; the bringing of the mixture to the proper consistency is of great importance. In all instances the exact portions of cement, sand, gravel or stone, and water should be ascertained and decided on in advance, and the same quantities used in making each and every batch for bricks or blocks; otherwise there will be a variation in the color and durability of the walls constructed. These mixes vary in formula from 1 to 4 to 1 to 5, but the greater the amount of Portland cement added, the stronger will the bricks or blocks prove when cured.

The mixing and tamping must be thorough, but a rake is the best tool to use to get the color uniform, and this work can best be done by experts. No exact rules can be given which would help one to understand just when the ingredients are sufficiently incorporated, one with the other, but the mixing should be done to secure a perfect uniformity of material, and water should be added until the mass is plastic enough to work without sticking or sagging when released and taken out of the mold or machine.

An enterprising manufacturer of stone machinery has the following to say in his circular:

"Concrete is not the coming age. IT IS HERE. Portland cement has made such vast strides in the last few years, and has been used in the work of the greatest importance so extensively and with such satisfaction, that its many valuable qualities are now known to everybody. We find it towering in the air, tunneling the earth, and, like Gibraltar, holding the sea at bay. And why not? It is as readily molded as wax; limited in form, color, and

design only by the imagination of the architect, and possesses the endurance of the pyramids. For building purposes it is unsurpassed, unequaled."

Then he goes on to tell of his machine, and it is certainly the real thing and a corker, and every builder can afford to own one, and he gives facts and figures that are certainly convincing.

He further says that it is impossible to anticipate all the requirements of the modern architect, but directions are sent with each machine, so that any carpenter can quickly improvise plates for special shapes or designs.

Among some of the advantages of hollow-concrete construction, he mentions the following:

Artistic appearance.

Cheapness of construction.

Buildings warm in winter and cool in summer.

Dry, ventilated walls, fire- and frost-proof.

Insurance is cheaper.

Requires no painting or repairs.

Blocks can be laid in the wall rapidly, and require but little mortar.

Plastering may be done on the back of the stone, saving lathing.

Free from rats, mice, and vermin.

Perfectly sanitary. Resists rain and dries quickly, while solid walls remain damp.

Can be molded into the most elaborate designs conceived by the architect; all that is required is the carpenter to carry it out.

The stone is thoroughly durable, becoming harder with age.

He has the following to say about Portland cement:

When Portland cement began to be used so extensively and by so many persons totally ignorant of its properties, and working without direction, there was much uncertainty as to its proper use, and particularly so, as sometimes good results were obtained with totally incorrect methods of handling. This proved only that "accidents will happen," or possibly that cement is like a hen—when it wants to set, it sets.

The question is not merely to get cement to set—it will do that anyway if it gets into contact with dampness. The question is one of economy and intelligence—to get the best possible results with the least possible expense. The foremost chemists and engineers of the world have made thousands of tests with the most accurate instruments and careful handling, have compared notes and verified results till we now have certain well-recognized "laws" to guide us, the most important of which are as follows:

1. Portland cement should have only enough water at first to start crystallization. Too much water "drowns" cement.
2. Water should be fed to the stone as crystallization requires.
3. Concrete continues to harden with increasing age, and the slower the crystals form, the larger and stronger they will be.

4. Concrete should be made compact, the grains of sand being worked till they thoroughly weld themselves into each other and close all the pores.
5. This is best accomplished by frequent but not too hard tamping. Very hard tamping with a small-faced tamp jars and bounces the material without packing it at all.
6. Pressure will not make a good stone, the reason being that when pressure is applied, the concrete is at once made compact at the top and bottom in thin layers. These layers effectually form a seal and prevent the air on the inside from escaping, and the air is compressed as the pressure is applied. As soon as the pressure is removed, the air expands, forces the grains of sand apart, and makes a stone that is weak and porous, and therefore easily subject to disintegration. On the contrary, light but frequent tamping works the air out and packs the grains together.
7. Concrete when first made has no more strength than so much damp sand. If a crack is started while in this condition, it will not reunite, but forms a permanent element of weakness; therefore concrete should not be disturbed or jarred after it has been molded or while it is setting. No nails should be used in making forms.

He further says that his machine embraces all of these fundamental principles, and is the only machine made with which an observance of all of them is possible.

Then he gives the cost of making stone blocks as follows:

The cost to make the blocks naturally varies in different countries and in different parts of the same country. In the northern part of the United States, the standard-size blocks usually cost from 6 to 8 cents each.

We give below an itemized cost based on present prices in our stone factory. These figures may be changed to meet local conditions.

14 yds. sand and gravel at.....$.50	$ 7.00
14 bbls. Portland cement at..... 1.50	21.00
4 laborers (3 molders and 1 mixer) at.. 1.50	6.00
Allowance for water and sundries.....	2.00
	$36.00

Dividing the total of $36.00 by 600, which is the number of blocks the above materials will produce and the four men make and take care of, gives the cost at 6 cents per block. When the blocks are made in large enough quantities to justify a concrete mixer, this cost can be considerably reduced.

Delivery of the blocks usually costs about 1 cent per block. Seventy of them can be hauled at a load. The usual selling price is from 16 to 20 cents, so that there is a very handsome profit in their manufacture.

Frequently they are made on the premises from the sand taken from the cellar, and then used in the walls of the building, thus saving hauling the sand away as well as delivery of the blocks.

He has the following to say about rock facing and coloring:

At a small additional expense the blocks may be molded 2 inches larger than they are to be in the finished wall. After the stones have partially set, this extra 2 inches is rocked off with a stone-cutter's pitching tool, making every block different, and presenting an effect in the wall that is strikingly artistic.

For churches, store fronts, and handsome residences, there is nothing that will equal it.

By using different-colored sands, crushed, white limestone, crushed granite or quartz, almost any natural stone may be duplicated so as to deceive even the experienced.

With the aid of different mineral colors, the stones may be made of almost any color, either solid, mottled, or stratified.

There is apparently no great necessity for a man who builds just one house to go and purchase a machine, as his carpenter will build the molds and be the pattern-maker. The Allen G. Thurman house at Columbus, Ohio, a remarkably fine-appearing house to-day, constructed in 1885, shows that years ago some one had an idea of a "cut-stone" house without the cut stone, and it certainly is a rational and perfect example; no freakish, stamped sheet-metal face about it. The blocks were cast in a mold and faced to resemble stone work, plain, pure, and simple; they are absolutely water-proof and perfect, though they were not made on a machine. Another example is located at Portchester, N. Y., built many years before the above, only it is concrete throughout, even to the stairs, partitions, etc.; and also the old house on Staten Island,

also built of made stone. They all testify that the block-machine man is an innovation, but any one who goes into the stone-making business needs just such a machine as is described in this book, and it certainly appears to be a money maker.

There is only one feature about it that I do not approve of, and that is, it makes a stone that is tied together with the same material as that which it is made of, and cannot, therefore, possibly be damp-proof and fit to plaster directly on the back, because concrete or the mortar between made stone, brick, or stone work is unquestionably a water conductor.

All walls should be constructed so that they will have a continuous air space between the inner and the outer wall, and these are the only walls that will give an even temperature summer and winter.

I see no reason why my esteemed friend, the manufacturer of the block machine here referred to, does not so adjust his machine to this idea and tie the inner and outer face of the block together, on a different plan, and with a material that will not make it a conductor of dampness; then it would certainly fill the bill completely. He should do this at once, or else throw his machine in the scrap heap, as it is simply a lie, and he is claiming for it what it is in no way entitled to in this respect.

Framed structures are doomed; wood is too costly to build with, and is a constant source of expense to maintain.

Brick and natural-stone buildings will be erected for

a few more years, but they too are doomed for many reasons, and just as soon as the new material, American Portland-cement concrete, is thoroughly understood and its full possibilities reached.

The recent seismic disturbance on the Pacific coast has proven conclusively that Portland cement, when it will be fully developed and thoroughly understood, will even be proof against such things as earthquakes, as it is now already proof against many other things.

Among the many advantages of hollow concrete-stone construction may be mentioned the following:

Hollow manufactured-stone construction effects a saving of material over solid brick or stone masonry, requires no wooden furrings, and therefore makes an absolutely fireproof wall or partition.

The cost of laying stone blocks is less than for brickwork, due to the fact that each block takes the place of 18 to 42 brick, requiring much less mortar in joints and less labor in setting.

A wall or partition made of the best of this manufactured material is stronger than an A No. 1 hard-burned brick wall of equal thickness, as laid at the present time. What about the soft and half-burned bricks that go into walls and disintegrate from dampness and freezing every winter; what of the fireproof qualities of such brick? They are not fireproof, as I have good reason to know. Last winter some boys built a fire on Election night against the gable end of a very fine, expensive stable situated at 56 E. 88th Street, New York City, belonging to a million-

aire, and the hard-burned bricks were spoiled, crumbled, and disintegrated, and the Insurance Company had to make it good with new brick, and about 2,000 new bricks had to be put in at considerable cost.

Brickwork done to-day is not what it used to be 30 or 35 years ago, when I have had brick walls and partitions built 60 feet high and 8 inches thick in the finest kind of buildings, and they are standing as solid to-day.

Natural stone, much of which, though apparently good when quarried, has to be dressed or broken to shape by stone masons at great expense, after it has been set for the facing of walls, crumbles or is washed away by the weather, while made stone, being easily molded to any desired form, will prove to be a far more economical building material than stone, and the most durable if properly made.

Hollow walls of molded stone give a dead air space, and therefore tend to prevent sudden temperature changes within a building, rendering it cool in summer and more easily warmed in winter. The hollow spaces may also be utilized for ventilation and other purposes.

STAIN.—To make a rich red-brown color for brown or red stone effect, or to renovate old stonework or brickwork, to fill up cracks, etc., use a thick wash made of the following:

4 ounces of white copperas cut in alcohol;
5 pounds of Prince's metallic dry;
3 gallons of sour lager beer;
2 good shovelfuls of Portland cement.

Let one man keep stirring it continually, while another man brushes it on. Soak the concrete or stone wall and wash it thoroughly with water before applying the stain.

Two coats are usually required on concrete, while one is generally sufficient on old stone or brickwork. If anything more is necessary to bring out the color effect, apply over it an ordinary brush coat of linseed oil.

When dry you will not be able to either scrape or cut the color off without taking the wall with it, and it will wear, from my knowledge and experience with it, 25 years.

This stain is excellent for chimney tops, old or new. Before applying, the dirt should always be washed off and joints pointed up with Portland-cement mortar 1 to 3, and colored. Add Venetian red if extra-rich brick-red is wanted.

PORTLAND CEMENT-SAND BRICK

THE manufacture of Portland cement-and-sand brick is far different from that of clay. Very small expense is required in curing the product. Upon being made, they are allowed to remain on the pallets overnight, and the next day they are piled up, protected from the rays of the sun, and kept wet for 10 days, after which they are soon ready for the market and the building operation.

Clay and also sand-lime brick require a longer period of time, and a lot of heat, labor, and expense before they are

fit to be placed in the wall; besides an enormous outlay of money is required to equip such plants, while the expense incurred in installing a cement-sand brick plant, making six to ten bricks at each operation, may be from $100.00 up, and a small one can be operated in a cellar or basement, where I have known one to be run successfully, making 700 to 1,000 bricks daily by hand.

There is a plant located in a city in northern New York, where also a high-grade Portland cement is likewise manufactured. One brick machine is in operation (there are altogether about 25 similar plants in the United States and Canada), and I have gleaned the following particulars as to what is being accomplished there: 25,000 to 28,000 bricks are made daily, and the plant cost $15,000.00; the pressure applied to each brick in the press is 180 tons, and each thousand brick costs, to manufacture, all charges of every kind whatsoever included, as follows:

Portland cement, 1½ bbls. @ $1.30	$1.95
Sand, 1½ yards	1.00
Labor, power, rent, and interest on cash investment	.90
Total cost per 1,000 bricks	$3.85

After expense of delivery, salesmen, and office staff, etc., has been allowed for, this plant earns a clear profit of $55.00 a day and sells all its product in the locality where it is established.

One machine operating down on the Jersey coast, where the sand does not freeze and costs practically nothing, the

plant heated in winter and running 300 days a year, making 25,000 bricks daily, would turn out 7,500,000 bricks which, if sold at the price of common stock brick, would net $3.00 to $4.00 per thousand, or $22,500.00 to $30,000.00 for the year's work; besides these bricks are classed with the best-pressed brick and would sell at a much higher price than the Jersey, red, half-baked, common, rotten brick

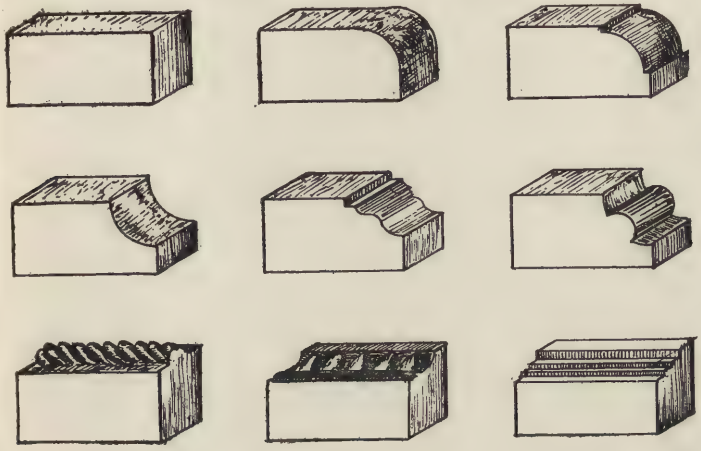


FIG. 8

that there is so much trouble with every winter in the walls of a naturally very damp sea-air atmosphere, and especially when walls have been plastered with cement stucco for the outside. I have seen it time and again, and the brick were graded and sold for A No. 1 all hard-burned.

What does common hard-burned clay brick and what does pressed brick cost you, and what does sand and also Portland cement cost you per barrel (car lots)?

Molded and every shape and style of brick can be made for interior decorations, fireplaces, tiles, also for floors, etc. Colors can be used and they can also be made absolutely impervious to moisture by a little extra trouble in their manufacture, besides for facing up a concrete building to give a clear air space between them and the concrete wall, or for veneering a stud-frame concrete-filled structure, or otherwise, nothing can be better or more reasonable.

There are vast architectural possibilities in this material in combination with concrete construction of foundation, cellar walls, underpinning, watertable, sills, lintels, quoins, voussoirs, door and window dressings, belt courses, friezes, cornices, columns, rails, steps, etc. Fig. 8 shows various forms of cement brick; an examination of these will show any one the possibilities of effective combinations that can be had.

WOODEN MOLDS

WOODEN MOLDS that are to be used to make a number of blocks should be strongly made; they must be substantial enough to resist the pressure exerted by the tamping. The joints should be so arranged that the mixture will not leak out.

Fig. 9 shows a view of a form of mold that will answer for nearly all purposes. It is constructed of wood 2 inches thick, and by removing the bolts, all the side pieces may

be removed. Fig. 10 shows how the side pieces are framed and locked together by the bolt.

When a wooden mold is to be used a number of times, it should be well painted, so as to prevent the moisture from warping the wood. A good paint for this purpose is made of $\frac{2}{3}$ linseed oil and $\frac{1}{3}$ paraffin oil. This not only preserves the mold, but allows the block to leave the mold more easily.

To save material the blocks may be made hollow by inserting cores which are also made of wood. In using

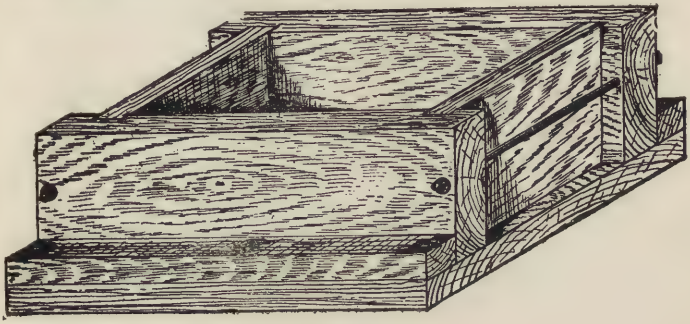


FIG. 9

cores be careful to always use rounded corners, as a crack is more likely to start from a square corner. The core should be slightly tapered, so that it may be easily withdrawn.

So much for the plain mold, which is but seldom used for making common blocks. Now if it is desired to have a molding like Fig. 11, this could be easily cast in a mold in which plain pieces of wood and molding (protected with the paint already mentioned) are so arranged as to give

the required shape. These pieces of wood can be nailed to one side, so that it can be easily removed. An examination of Fig. 12 will show the idea.

In the case of lintels to place over window openings, the molding is returned at each end to the wall end. In cases of this kind the mold is made of the required size and the molding mitred, so as to make the proper form.

The block-maker should keep on hand different kinds of moldings, so that he will be prepared to make up a variety of designs, and if he will turn out good, honest



Fig. 10

work, and use a little ingenuity in preparing the molds, as outlined above, he will make a reputation for himself and his products, and will find himself recommended by architects who want a good job done.

Artistic effects can be had by making the blocks with plain faces on which raised festoons or other designs appear. Figs. 13, 14, and 15 will show a few examples of blocks with such designs.

Ornamental blocks of this sort can be very easily made

by having in stock a few stamped, galvanized-iron ornaments, such as are used by cornice-makers, and which can be had quite cheaply.

Pieces of wood a little thicker than the depth of the

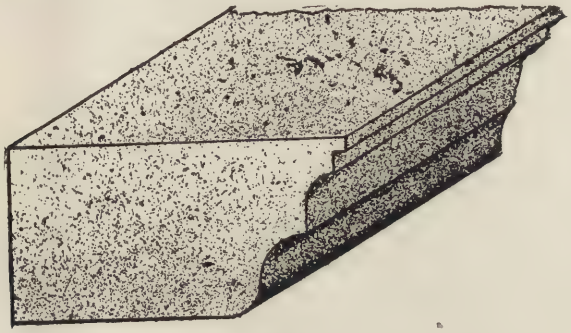


FIG. 11

ornament are placed at the bottom of the mold, so as to leave a little more than the height of the ornament. The central portion is to be filled flush with plaster of Paris,

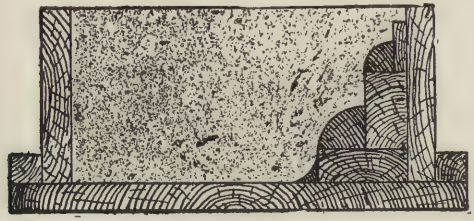


FIG. 12

and the ornament placed in it downwards, thus forming a mold of the ornament. When the plaster has set, the ornament is withdrawn and the mold is complete.

To prevent the stamped, iron ornament from falling

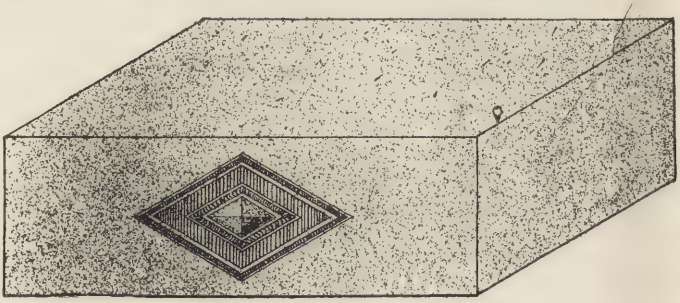


FIG. 13

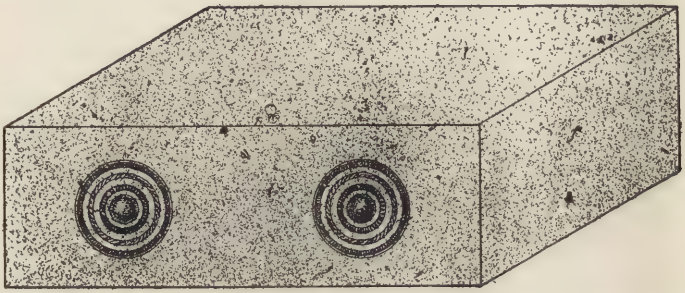


FIG. 14

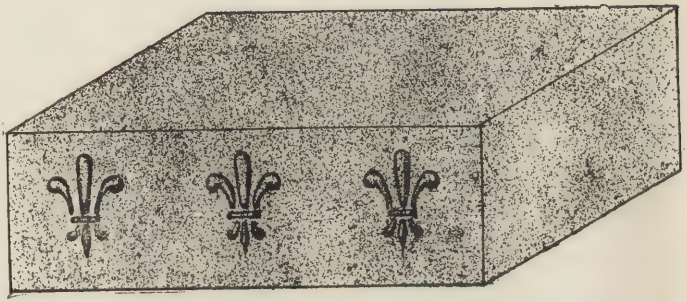
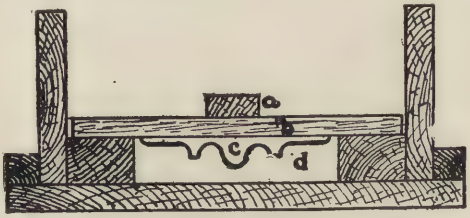


FIG. 15

too deep in the plaster, it should be nailed to a piece of board, as shown in Fig. 16. The ornament should be oiled to prevent its sticking to the plaster. The plaster should be allowed to harden thoroughly before the concrete is placed in the mold. In practically every case the plaster mold will be found stuck to the cast, but this can be very easily dampened and scraped away. Of course with this method it is necessary to make a new mold of plaster for every block, as the plaster will last for only one casting. This, however, is a simple matter, as the molds are so easily made.



a = handle, b = board, c = ornament, d = plaster.

FIG. 16

Many friezes and moldings that are suitable for concrete are made in stamped metal, and even if the block-maker has only a few of these, he can make unlimited designs by using them in different combinations.

Of course these sheet-metal designs will not last like the cast-iron molds which the block-machine people furnish, but if they are backed up with a cement-and-sand mixture, so that they will not be crushed out of shape by the tamping, they will last long enough to turn out a number of creditable and original jobs.



FIG. 17



FIG. 18

This suggestion of using stamped metal for forms will be a new one to most block-makers, but it is one worthy of thought, as it will enable one to create something different. There has been too much sameness about concrete blocks.

It will be found that even if a small selection of the stamped, iron ornaments and borders are kept on hand,

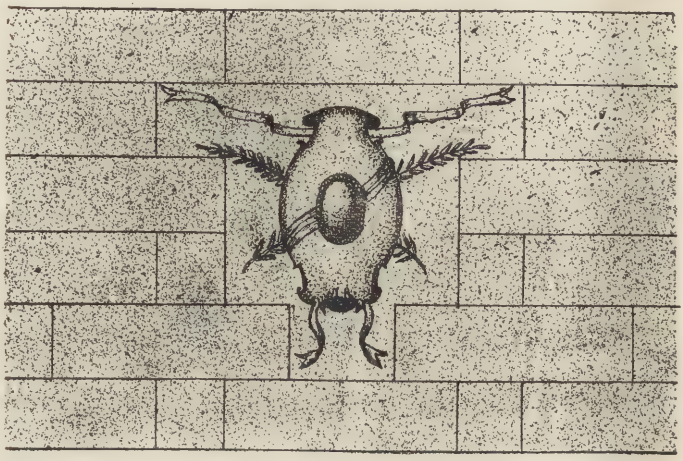


FIG. 19

they will open a field to the ambitious block-maker to carry out the original ideas of architects, which under ordinary conditions would be impracticable. Fig. 17 gives designs of a few ornaments which can be had in stamped metal, and Fig. 18 gives some suitable borders.

When large ornamental pieces like Fig. 19 are cast, it is well to reinforce them. A simple and good way is to

use a mesh wire screen cut to the shape of the casting and well imbedded. A design similar to Fig. 19 (size about 16″×29″) can be had for a few dollars and can be cast without much trouble in the manner just described. The architectural value of such an ornament in a large unbroken wall of blocks needs no further mention, as it speaks for itself, turning a dull, monotonous expanse of rectangular block wall into a suitable background, and forming an object of beauty. A little ornament used with taste goes a very long way.

ARE ARCHITECTS AND BUILDERS AGAINST THE USE OF THE COMMON CONCRETE BLOCK, AND WHY?

SINCE the concrete block is more convenient, more efficient, and cheaper than other building material, it would naturally follow that it should rapidly jump into favor, taking the place of wood, brick, and stone, and be generally adopted for all ordinary construction. The growth of the block industry has indeed been phenomenal, pushed mushroom-like by the machine manufacturers, but it is not a healthy growth—too much slashing and cutting—and even yet it plays but a small part in the building operations of the country. It is quite evident on all sides that concrete blocks meet with opposition and suspicion on the part of architects and builders,

and in consequence are much less generally adopted than their merits would appear on the surface to warrant. It is neither just nor expedient to attribute this opposition to prejudice against a new material, as it is not a new material, as I have already shown. The machine manufacturers and the block-makers must get down to business and remove the real grounds on which the opposition is based to the common-style concrete block as now produced. Architects and engineers have no prejudice against concrete, but, on the contrary, welcome it as a building material by means of which they can obtain results never before within their reach. They are also keenly watching the block industry, and are ready to adopt block construction as soon as they can secure a product which meets their ideas as to utility and beauty.

Fortunately no material is so elastic in its capabilities as concrete, and no other can with so little effort be adapted to produce any effect desired. It is hardly expected that the block of the present day will be the block of the future; the type which is most economical, practical, and artistic will gradually come to the front, and that which is costly, clumsy, and ugly will become a thing of the past. To make a success the manufacturer must study the wants of cultivated taste also, and must not hesitate to throw the old block machines into the scrap heap, and get up to date, with the latest ideas, processes, and machinery. Of course this seems like throwing good money away, but the greater sales due to an improved block will make it a paying proposition.

The objections which architects and builders make to blocks now on the market are chiefly the following:

1st. Poor materials and workmanship.

2d. Fixed and monotonous dimensions.

3d. Too heavy for ease of handling.

4th. Inartistic appearance in the wall.

With reference to material and work, shoddy, weak, and crumbling blocks are far too often met with. Good concrete should be hard and dense, and should ring like metal when struck with a hard substance. If the blocks sound dead when struck and break easily with an earthy fracture, the mixture has been too poor, or the working too dry. It don't pay, for the sake of low, factory cost, to turn out work of this kind. You may be certain of one thing, and that is, if there is any money to be made in the concrete-block business, it will be made by supplying only a first-class article at a living price, and not in any other way.

Will any one argue that it pays to make rotten blocks at a factory cost of a cent or two less than good ones? A man will soon be known by the blocks he makes, and if they are rotten, he will soon be down and out.

As to fixed dimensions of blocks, the standard length of 32 inches, divided into halves, thirds, and quarters, is very convenient, and is generally conformed to, even by architects, for simple work, without great objection. To be fully successful, however, and to overcome all prejudice, the block-maker must be ready to furnish any size or shape that may be called on to suit architectural work.

It would be very nice for the block-maker if he could confine himself to a size and let customers "take it or leave it." But such an attitude bars the way to any wide use of blocks in varied and attractive buildings, and cannot long be maintained without loss of trade.

Architects also want courses of greater or less height than the 9-inch standard, and all manner of copings, water-tables, sills, belts, cornices, columns, balustrades, and capitals. All this may frighten the timid and conservative block-maker, but it is in that direction that success lies, and the production of these special shapes and sizes requires only ingenuity, courage, and mechanical skill. Until the architect can design whatever he desires to, knowing it will be produced, he will be shy of the block-maker and his product. He will, of course, readily appreciate that special shapes cost more than standard, and if he knows he can get just what he wants, he will be more likely to accept, as far as possible, what can be conveniently and cheaply furnished.

Preference should be given, therefore, by the block-maker, to the machinery or appliances which will permit of the greatest variety of manufacture; and the greatest business success is most likely to come to him who shows the least inclination to get into a rut, and is most ready to adapt his product to the wants of his patrons.

The objection to the weight of one-piece block comes chiefly from masons and contractors. Hoisting 12″×32″ blocks weighing 180 lbs. to the upper stories of a building, and placing them in the wall, is a considerable task, and it

is largely on this account that the half-block of the two-piece system, 24 inches long, weighing only 64 lbs., is received with so much favor. It must be remembered, however, that the two-piece blocks make a wall with over 50% opening, and a one-piece block of the same thickness of surfaces—2½ inches—would also be light to handle, and doubtless very popular. The one-piece block of the future should be 24 inches long, with a thickness of surfaces of not over 3½ inches. Such a block, 12 inches wide and 9 inches high, will weigh about 100 lbs., and if well and strongly tied with light material and honestly made, will bear required handling and stress.

But it is to the appearance of concrete blocks, as regularly made and used, that architects and others of taste and sound judgment in such matters make the greatest objection. Anything that savors of imitation, that pretends to be what it is not, will always be condemned by those who know the difference between the good and the bad in architecture. The common concrete block is an attempt at imitation of rock-faced quarry stone; no two natural stones will break alike on the face, so the block machine furnishes a few different rock-faced plates of the same size of block, while the great beauty of a rock-faced stone ashlar is the irregularity in the sizes, etc., of the whole, with the exception of level beds and plumb-cut joints. And the block-maker strives as best he can to shuffle up his product from his different face plates, but his labor and shuffling are in vain. It is surprising how unerringly the eye will pick out the spots where two of a

kind will have flocked together in the wall, and not as the Dutchman had it—"Birds of a feather go one by himself." Something wrong is quickly detected. It is an eyesore, and very objectionable bad art.

The "rock-faced galvanized iron" of our village and town store fronts is a no more glaring fraud. The imitation rock-faced block has been weighed in the balance and has been found to be sadly wanting, and the verdict is, "It must go!"

The fine-brick manufacturers make rock-faced brick in a rational way that have not the above objections. Why did the concrete-block man not follow in his steps if he was called on to produce such material by the architectural fraternity, which I very much doubt? No, it is the machine man and those who have no taste in matters of art who are responsible for this monstrosity.

Now let us inquire what is imitation, and how concrete may be made to stand on its merits and look like what it really is—a cast, artificial stone, which cannot help looking like natural sandstone or limestone made up of the same materials, bound together by carbonate of lime or soluble silicates slowly deposited in its pores. We need never be afraid that concrete will be condemned for its stony look, since that is its nature. All one need avoid is giving the work an appearance which is unnatural, such as the rock-face. Smooth, rough, ribbed, and paneled surfaces are also good ornamental patterns for friezes or belt courses, and are entirely legitimate and equally characteristic of terra cotta or concrete. Follow terra cotta and

you will be right, but keep shy of galvanized iron and the metal designs and tin cornices, etc., etc. The thing to be avoided is pretense—the attempt to deceive the observer into the belief that the material he sees is something different from what it really is. "All things are not what they seem."

The surface that best satisfies the eye of the architect and critic is a rough and varied one, rather than the very smooth, glassy, and dead look which rich cement mixtures have. The film of cement which coats the face of the work is certainly monotonous and unattractive; besides it is very liable to hair crack. This film can readily be removed, and very beautiful effects are thus obtained, especially when crushed stone or beach gravels containing pebbles of various colors have been used.

STANDARD SPECIFICATIONS FOR BLOCKS

MANY failures of buildings of concrete blocks have occurred, due to the ignorance of the makers, and the fault is blamed on concrete rather than on the makers, who are at fault.

The National Association of Cement Users, realizing the above facts, appointed a committee to investigate the industry, and to make experiments and investigations. The results of their experience were embodied in a standard form of specifications. These specifications are prac-

tically the same as the directions previously given, but it will be of interest to have them for reference in this book. The specifications are as follows:

Concrete hollow blocks made in accordance with the following specifications, and meeting the requirements thereof, may be used in building construction, subject to the usual form of approval required of other materials of construction by the Bureau of Building Inspection.

1. CEMENT.—The cement used in making sand blocks shall be Portland cement, capable of passing the requirements as set forth in the "Standard Specifications for Cement" by the American Society for Testing Materials.

2. SAND.—The sand used shall be suitable siliceous material, passing the one-fourth-inch-mesh sieve, clean, gritty, and free from impurities.

3. STONE OR COARSE AGGREGATE.—This material shall be clean, broken stone, free from dust, or clean, screened gravel passing the three-quarter-inch-, and refused by the one-quarter-inch-mesh sieve.

4. UNIT OF MEASUREMENT.—The barrel of Portland cement shall weigh 380 pounds net, either in barrels or subdivisions thereof, made up of cloth or paper bags, and a cubic foot of cement shall be called not to exceed 100 pounds or the equivalent of 3.8 cubic feet per barrel. Cement shall be gauged or measured either in the original package as received from the manufacturer, or may be weighed and so proportioned; but under no circumstances shall it be measured loose in bulk.

5. PROPORTIONS.—For exposed exterior or bear-

ing walls: (*a*) Concrete hollow blocks, machine made, using semi-wet concrete or mortar, shall contain one (1) part cement, not to exceed three (3) parts sand, and not to exceed four (4) parts stone, of the character and size before stipulated. When the stone shall be omitted, the proportions of sand shall not be increased, unless it can be demonstrated that the percentage of voids and tests of absorption and strength allow in each case of greater proportions, with equally good results. (*b*) When said blocks are made of slush concrete in individual molds and allowed to harden undisturbed in same before removal, the proportions may be one (1) part cement to not to exceed three (3) parts sand and five (5) parts stone, but in this case also, if the stone be omitted the proportion of sand shall not be increased.

6. MIXING.—Thorough and vigorous mixing is of the utmost importance.

(*a*) HAND MIXING.—The cement and sand in correct proportions shall first be perfectly mixed dry; the water shall then be added carefully and slowly in proper proportions, and thoroughly worked into and throughout the resultant mortar; the moistened gravel or broken stone shall then be added, either by spreading same uniformly over the mortar, or by spreading the mortar uniformly over the stones, and then the whole mass shall be vigorously mixed together until the coarse aggregate is thoroughly incorporated with and distributed throughout the mortar.

(*b*) MECHANICAL MIXING.—Preference shall be given to mechanical mixers of suitable design, and adapted to the

particular work required of them; the sand and cement, or sand and cement and moistened stone shall, however, be first thoroughly mixed before the addition of water, and then continued until the water is uniformly distributed or incorporated with the mortar or concrete, provided, however, that when making slush or wet concrete (such as will quake or flow), this procedure may be varied with the consent of the Bureau of Building Inspection, architect or engineer in charge.

7. MOLDING.—Due care shall be used to secure density and uniformity in the blocks by tamping or other suitable means of compression. Tamped blocks shall not be finished by simply striking off with a straight-edge, but, after striking off the top surfaces, shall be troweled or otherwise finished to secure density and a sharp and true arris.

8. CURING.—Every precaution shall be taken to prevent the drying out of the blocks during their initial set and first hardening. A sufficiency of water shall first be used in the mixing to perfect the crystallization of the cement, and, after molding, the blocks shall be carefully protected from wind currents, sunlight, dry heat, or freezing, for at least five (5) days, during which time additional moisture shall be supplied by approved methods, and occasionally thereafter until ready for use.

9. AGING.—Concrete hollow blocks in which the ratio of cement to sand be one-third ($\frac{1}{3}$) (1 part cement to 3 parts sand) shall not be used in the construction of any building in the (City) of ————————, until they have attained the age of not less than three (3) weeks.

Concrete hollow blocks in which the ratio of cement to sand be one-half (½) (1 part cement to 2 parts sand) may be used in construction at the age of two (2) weeks, with the special consent of the Bureau of Building Inspection and the architect or engineer in charge.

Special blocks of rich composition, required for closures, may be used at the age of seven (7) days, with the special consent of the same authorities.

The time herein named is conditional, however, upon maintaining proper conditions of exposure during the curing period.

10. MARKING.—All concrete blocks shall be marked for purposes of identification, showing name of manufacturer or brand, date (day, month, and year) made, and composition or proportions used, as, for example, 1–3–5, meaning 1 cement, 3 sand, and 5 stone.

11. THICKNESS OF WALLS.—The thickness of bearing walls for any building where concrete hollow blocks are used may be ten (10) per cent less than is required by law for brick walls. For curtain walls or partition walls, the requirements shall be the same as in the use of hollow tile, terra-cotta, or plaster blocks.

12. PARTY WALLS.—Hollow concrete blocks shall not be permitted in the construction of party walls, except when filled solid.

13. WALLS, LAYING OF.—Where the face only is of hollow concrete block, and the backing is of brick, the facing of hollow block must be strongly bonded to the brick either with headers projecting four (4) inches into

the brickwork, every fourth course being a heading course, or with approved ties; no brick backing to be less than eight (8) inches. Where the walls are made entirely of concrete blocks, but where said blocks have not the same width as the wall, every fifth course shall extend through the wall, forming a secure bond, when not otherwise sufficiently bonded. All walls, where blocks are used, shall be laid up with Portland-cement mortar.

14. GIRDERS OR JOISTS.—Wherever girders or joists rest upon walls so that there is a concentrated load on the block of over two (2) tons, the blocks supporting the girder or joists must be made solid for at least eight (8) inches from the inside face. Where such concentrated load shall exceed five (5) tons, the blocks for at least three courses below, and for a distance extending at least eighteen (18) inches each side of said girder, shall be made solid for at least eight (8) inches from the inside face. Wherever walls are decreased in thickness, the top course of the thicker wall shall afford a full, solid bearing for the webs or walls of the courses of blocks above.

15. LIMIT OF LOADING. — No wall, nor any part thereof, composed of concrete hollow blocks, shall be loaded to an excess of eight (8) tons per superficial foot of the area of such blocks, including the weight of the wall, and no blocks shall be used in bearing walls that have an average crushing strength of less than 1,000 pounds per square inch of area, at the age of twenty-eight (28) days; no deduction to be made in figuring the area for the hollow spaces.

16. SILLS AND LINTELS.—Concrete sills and lintels

shall be reinforced by iron or steel rods in a manner satisfactory to the Bureau of Building Inspection and the architect or engineer in charge, and any lintels spanning over 4 feet, 6 inches shall rest on block solid for at least 8 inches from the face next to the opening and for at least three courses below the bottom of the lintel.

17. HOLLOW SPACE.—The hollow space in building blocks used in bearing walls shall not exceed the percentage given in the following table for different-height walls, and in no case shall the walls or webs of the block be less in thickness than one-fourth their height. The figures given in the table represent the percentage of such hollow space for different-height walls.

Stories.	1st.	2d.	3d.	4th.	5th.	6th.
1 and 2.	33	33	..	..	..	..
3 and 4.	25	33	33	33	..	..
5 and 6.	20	25	25	33	33	33

18. APPLICATION FOR USE.—Before any such material be used in buildings, an application for its use and for a test of the same must be filed with the Bureau of Building Inspection. In the absence of such a Bureau, the application shall be filed with the chief of any department having such matters in charge. A description of the material and a brief outline of its manufacture and proportions used must be embodied in the application. The name of the firm or corporation, and the responsible officers thereof, shall also be given, and changes in same thereafter promptly reported.

19. PRELIMINARY TEST.—No hollow concrete blocks shall be used in the construction of any building unless the maker of said blocks has submitted his product to the full tests required herein, and placed on file with the Bureau of Building Inspection, or other duly authorized official, a certificate from a reliable testing laboratory, showing that representative samples have been tested and successfully passed all requirements hereof, and giving in detail the results of the tests made.

No concrete blocks shall be used in the construction of any building until they have been inspected and approved, or, if required, until representative samples be tested and found satisfactory. The results of all tests made, whether satisfactory or not, shall be placed on file in the Bureau of Building Inspection. These records shall be open to inspection upon application, but need not necessarily be published.

20. ADDITIONAL TESTS.—The manufacturer and user of such hollow concrete blocks, or either of them, shall at any and all times have made such tests of the cements used in making such blocks, or such further tests of the completed blocks, or of each of these at their own expense, and under the supervision of the Bureau of Building Inspection, as the chief of said Bureau shall require.

In case the result of tests made under this condition should show that the standard of these regulations is not maintained, the certificate of approval, issued to the manufacturer of said blocks, will at once be suspended or revoked.

21. CERTIFICATE OF APPROVAL.—Following the

application called for in clause No. 18, and upon the satisfactory conclusion of the tests called for, a certificate of approval shall be issued to the maker of the blocks by the Bureau of Building Inspection. This certificate of approval will not remain in force for more than four months, unless there be filed with the Bureau of Building Inspection, at least once every four months following, a certificate from some reliable physical testing laboratory, showing that the average of at least three (3) specimens tested for compression, and at least three (3) specimens tested for transverse strength, comply with the requirements herein set forth. The said samples to be selected by a building inspector, or by the laboratory, from blocks actually going into construction work.

22. TEST REQUIREMENTS.—Concrete hollow blocks must be subjected to the following tests—transverse, compression, and absorption—and may be subjected to the freezing and fire tests, but the expense of conducting the freezing and fire tests will not be imposed upon the manufacturer of said blocks.

The test samples must represent the ordinary commercial product of the regular size and shape used in construction. The samples may be tested as soon as desired by the applicant, but in no case later than sixty days after manufacture.

TRANSVERSE TEST.—The modulus of rupture for concrete blocks at 28 days must average one hundred and fifty, and must not fall below one hundred in any case.

COMPRESSION TEST.—The ultimate compressive strength

at 28 days must average one thousand (1,000) pounds per square inch, and must not fall below seven hundred in any case.

ABSORPTION TEST.—The percentage of absorption (being the weight of water absorbed, divided by the weight of the dry sample) must not average higher than 15%, and must not exceed 22% in any case.

23. CONDEMNED BLOCK.—Any and all blocks, samples of which, on being tested under the direction of the Bureau of Building Inspection, fail to stand at twenty-eight (28) days the tests required by this regulation, shall be marked condemned by the manufacturer or user, and shall be destroyed.

24. CEMENT BRICK.—Cement brick may be used as a substitute for clay brick. They shall be made of 1 part cement to not exceeding 4 parts clean, sharp sand, or 1 part cement to not exceeding 3 parts clean, sharp sand and 3 parts broken stone or gravel passing the one-half-inch and refused by the one-quarter-inch-mesh sieve. In all other respects cement brick must conform to the requirements of the foregoing specifications.

The foregoing specifications, together with previous directions, cover practically the whole subject of the making of concrete blocks. To be successful in this line of manufacturing, you must produce a first-class block, and this can be done by strictly following these rules and directions. Show that you have faith in blocks by building your office with them. Be enthusiastic and you will succeed.

TESTING HOLLOW CONCRETE BLOCKS

ON important work, especially for factories and warehouses which are to carry heavy loads on the floors, it is a good plan to test the blocks. The rules adopted by the National Association of Cement Users are good ones to follow; they are as follows:

1. All tests required for approval shall be made in some laboratory of recognized standing, under the supervision of the engineer of the Bureau of Building Inspection, or the architect or engineer in charge, or all of these. The manufacturer may be present or represented, during said tests, if he so desires. Approval tests are made at the expense of the applicant.

2. For the purposes of the tests, at least twelve (12) samples or test pieces must be provided. Such samples must represent the ordinary commercial product and may be selected from stock by the Bureau of Building Inspection, or in the absence of such a Bureau, by the architect or engineer in charge.

In cases where the material is made and used in special shapes or forms too large for testing in the ordinary machines, smaller-sized specimens shall be used, as may be directed.

3. In addition to the tests required for approval, the weight per cubic foot of the material must also be obtained and recorded.

4. Tests shall be made in series of at least three (3), except that in the fire tests a series of two (four samples) are sufficient.

Transverse tests shall be made on full-sized samples. Half samples may be used for the crushing, freezing, and fire tests. The remaining samples are kept in reserve in case duplicate or confirmatory tests be required. All samples must be marked for identification and comparison.

5. The transverse test shall be made as follows: The samples shall be placed flatwise on two rounded knife-edge bearings set parallel 7 inches apart. A load is then applied on top, midway between the supports, and transmitted through a similar rounded knife edge, until the sample is ruptured. The modulus of rupture shall then be determined by multiplying the total breaking load in pounds by twenty-one (three times the distance between supports in inches), and then dividing the result thus obtained by twice the product of the width in inches by the square of the depth in inches:

$$R=\frac{3WL}{2bd^2}.$$

No allowance should be made in figuring the modulus of rupture for the hollow spaces.

6. The compression test shall be made as follows: Samples must be cut from blocks so as to contain a full web section. The sample must be carefully measured, then bedded flatwise in plaster of Paris, to secure a uniform bearing in the testing machine, and crushed. The total

breaking load is then divided by the area in compression in square inches. No deduction is to be made for hollow spaces; the area will be considered as the product of the width by the length.

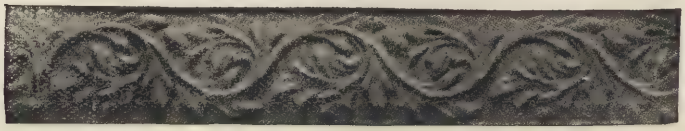
7. The absorption test shall be made as follows: The sample is first thoroughly dried to a constant weight, at not to exceed 212° F. The weight must be carefully recorded. It is then placed in a pan or tray of water, face downward, immersing it to a depth of at least 2 inches. It is again carefully weighed at the following periods: 30 minutes, 4 hours, and 48 hours, respectively, from the time of immersion, being replaced in the water in each case as soon as the weight is taken. Its compressive strength while still wet is then determined at the end of the 48-hour period, in the manner specified in section 6.

8. The freezing test shall be made as follows: The sample is immersed, as described in section 7, for at least 4 hours, and then weighed. It is then placed in a freezing mixture or a refrigerator, or otherwise subjected to a temperature of less than 15° F. for at least 12 hours. It is then removed and placed in water, where it must remain at least 1 hour, the temperature of which is at least 150° F. This operation is repeated ten (10) times, after which the sample is again weighed while still wet from the last thawing. Its crushing strength should then be determined as called for in section 6.

9. The fire test is made as follows: Two samples are placed in a cold furnace in which the temperature is gradually raised to 1,700° F. The test piece must be sub-

jected to this temperature for at least 30 minutes. One of the samples is then plunged in cold water (about 50° to 60° F.) and the results noted. The second sample is permitted to cool gradually in air, and the results noted.

10. The following requirements must be met to secure an acceptance of the materials: The modulus of rupture for concrete blocks at 28 days old must average one hundred and fifty and must not fall below one hundred in any case. The ultimate compressive strength at 28 days must average one thousand pounds per square inch and must not fall below seven hundred in any case. The percentage of absorption (being the weight of water absorbed divided by the weight of the dry sample) must not average higher than 15% and must not exceed 22% in any case. The reduction of compressive strength must not be more than 33⅓%, except that when the lower figure is still above one thousand pounds per square inch, the loss in strength may be neglected. The freezing and thawing process must not cause a loss in weight greater than 10%, nor a loss in strength of more than 33⅓%, except that when the lower figure is still above one thousand pounds per square inch, the loss in strength may be neglected. The fire test must not cause the material to disintegrate.



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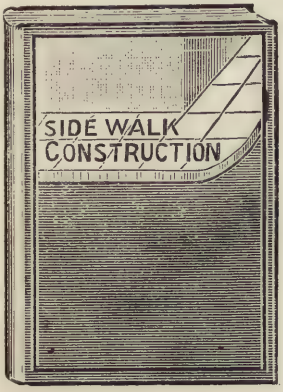
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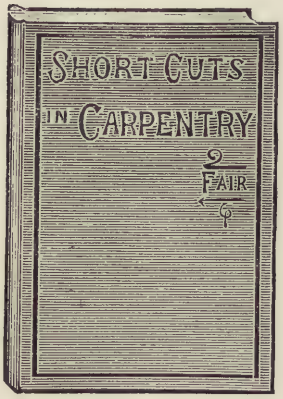
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